

AMENDMENTS TO THE SPECIFICATION:

Please substitute the following amended title for the pending title of the application:

IMAGING MEMBERS MEMBER HAVING A DUAL CHARGE TRANSPORT LAYER

Please substitute the following amended paragraph for the pending paragraph beginning on page 1, line 17:

An electrophotographic imaging member device comprising at least one photoconductive insulating layer can be imaged by uniformly depositing an electrostatic charge on the imaging surface of the electrophotographic imaging member and then exposing the imaging member to a pattern of activating electromagnetic radiation, such as [,] light, which selectively dissipates the charge in the illuminated areas of the imaging member while leaving behind an electrostatic latent image in the non-illuminated areas. This electrostatic latent image may then be developed to form a visible image by depositing finely divided electroscopic marking toner particles on the imaging member surface. The resulting visible toner image can then be transferred to a suitable receiving member such as paper.

Please substitute the following amended paragraph for the pending paragraph beginning on page 1, line 28:

A number of current imaging members are, for example, referred to as multilayered photoreceptors that, in a negative charging system, comprise a supporting substrate, an electrically conductive layer, an optional charge blocking layer, an optional adhesive layer, a charge generating layer, a charge transport layer, and an optional protective or overcoating layer. The imaging members of multilayered photoreceptors can take several forms, for example, flexible belts, rigid drums and the like. Flexible photoreceptor belts may either be seamed or seamless belts. An anti-curl layer may, for example, be employed on the back side of the substrate support, opposite to the electrically active layers, to achieve the desired photoreceptor flatness.

Please substitute the following amended paragraph for the pending paragraph beginning on page 2, line 7:

Multilayered photoreceptors, when functioning under electrophotographic machine service conditions, do exhibit typical mechanical failures such as frictional abrasion, wear, and surface cracking. Surface cracking frequently seen in belt photoreceptors is induced either due to dynamic fatigue of the belt flexing over the supporting rollers of a machine belt support module or caused by exposure to airborne chemical contaminants such as solvent vapors and corona species emitted by machine charging subsystems while the photoreceptor belt is subjected to bending stress. The cracks start on the surface of the transport layer, ~~propagated~~ propagate through the transport layer and eventually ~~caused~~ cause the delamination of the cracked transport layer from the generator layer. The charges on the photoreceptor surface leak through the cracks and cause dark lines printed out on the prints. Such a short photoreceptor life profoundly increases the UMR rate and cost. In fact, photoreceptor surface cracking is one of the common and most urgent mechanical problems seen, particularly[[,]] in flexible belts. This problem requires quick resolution, because the cracks so generated produce printout defects that seriously impact copy quality.

Please substitute the following amended paragraph for the pending paragraph beginning on page 3, line 7:

U.S. Patent No. 4,806,443, the disclosure of which is also totally incorporated herein by reference, describes a charge transport layer including a polyether carbonate obtained from the condensation of ~~N,N'-diphenyl-N,N'-bis(3-hydroxyphenyl)-[1,1'-biphenyl]-4,4'-diamine~~ N,N'-diphenyl-N,N'-bis(3-hydroxyphenyl)-[1,1'-biphenyl]-4,4'-diamine and diethylene glycol bischloroformate. U.S. Patent No. 4,025,341 describes a photoreceptor with a charge transport layer including a hole transporting material such as poly(oxycarbonyloxy)-2-methyl-1,4-phenylene cyclohexylidene-3-methyl-1,4-phenylene.

Please substitute the following amended paragraph for the pending paragraph beginning on page 5, line 1:

Moreover, in further embodiments there are also provided flexible photoconductive imaging members with dual charge transport layers, wherein the second or top charge transport layer contains excellent and high mobility charge transport compounds, such as hole transport molecules. In these embodiments the high mobility refers, for example, to at least about 50 percent higher capacity in hole transport mobility than the known aryl amines. Such high mobility hole transport compounds exhibit good compatibly compatibility with the resin binder, produce reduced or no crystallization of the hole transport molecules, and increased coating layer robustness to produce enhanced mechanical function of the imaging member top layer. This is particularly true when utilizing reduced amounts of from about 20 to about 40 percent by weight of the high mobility hole transport molecules in the second or top charge transport layer.

Please substitute the following amended paragraph for the pending paragraph beginning on page 6, line 12:

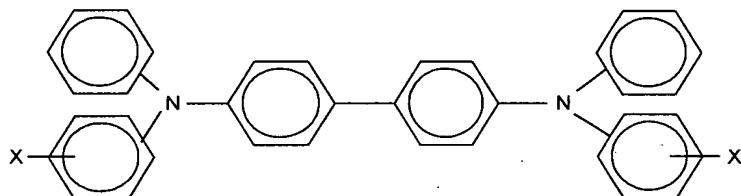
Also disclosed herein is a negatively charged electrophotographic imaging member comprising

- a supporting substrate having an optional conductive surface or layer,
- an optional hole blocking layer,
- an optional adhesive layer,
- a charge generating layer,

a dual charge transport layer having a first (bottom) portion or layer and a second (top) portion or layer, each of which is a solid solution comprising a particular hole mobility organic charge transporting compound molecularly dispersed or dissolved in a film forming polymer binder. The hole mobility organic charge transporting compound utilized in the first layer preferably comprises triphenylmethane, bis(4-diethylamine-2-methylphenyl) phenylmethane, styrene stilbene, and hydrozone hydrazone; otherwise, an aromatic amine comprising tritylamine; arylamine; enamine; phenanthrene diamine; N,N'-bis-(3,4-dimethylphenyl)-4-biphenyl amine; N,N'-bis(4-methylphenyl)-N,N'-bis(4-ethylphenyl)-1,1'-3,3'-dimethylbiphenyl 4,4'diamine N,N'-bis-

(4-methylphenyl)-N,N'-bis(4-ethylphenyl)-1,1'-(3,3'-dimethylbiphenyl)-4,4'-diamine; 4,4'-bis(diethylamino)-2,2'-dimethyltriphenylmethane 4,4'-bis(diethylamino)-2,2'-dimethyltriphenylmethane; N,N'-diphenyl-N,N'-bis(3-methylphenyl)-[1,1'-biphenyl]-4,4'-diamine; N,N'-diphenyl-N,N'-bis(4-methylphenyl)-1,1'-biphenyl-4,4'-diamine; N,N'-diphenyl-N,N'-bis(alkylphenyl)-1,1'-biphenyl-4,4'-diamine; N,N'-diphenyl-N,N'-bis(3-methylphenyl)-[1,1'-biphenyl]-4,4'-diamine; N,N'-diphenyl-N,N'-bis(4-methylphenyl)-1,1'-biphenyl-4,4'-diamine; N,N'-diphenyl-N,N'-bis(alkylphenyl)-1,1'-biphenyl-4,4'-diamine; and N,N'-diphenyl-N,N'-bis(chlorophenyl)-1,1'-biphenyl-4,4'-diamine. For example, included herein are the aromatic diamines that are generally represented by the molecular Formula (I) below:

FORMULA (I)



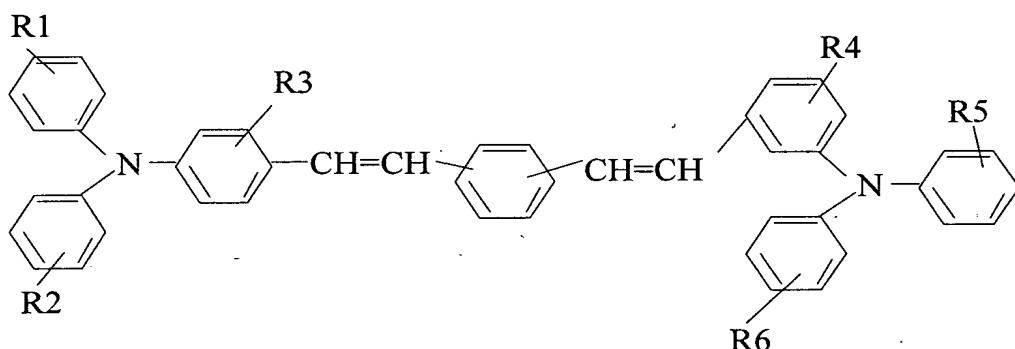
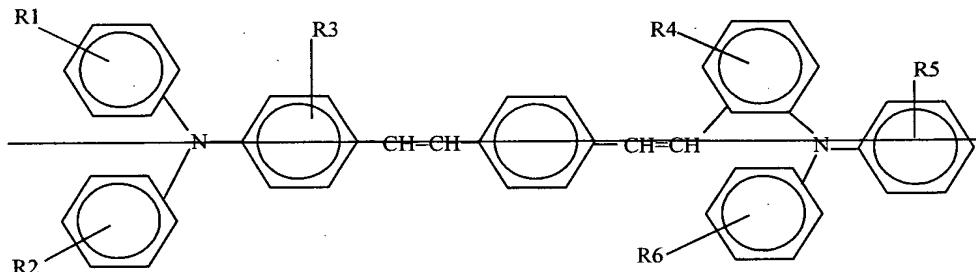
wherein X is selected from the group consisting of alkyl, hydroxy, and halogen. The first (bottom) charge transport layer comprises from about 50 to about 90 weight percent, preferably from about 50 to about 70 weight percent, of the hole transporting compound set forth above.

Please substitute the following amended paragraph for the pending paragraph beginning on page 6, line 12:

The charge or hole transporting compound incorporated in the second or top charge transport layer comprises charge transporting compounds[[,]] having enhanced hole transporting capacity (about 50 percent hole mobility improvement) than those aromatic diamines described above. Such a compound is suitable for use in this development because its enhanced hole transport capability will allow for usages of lower concentrations in the top charge transport layer formulation. This will therefore allow for mechanical property improvement without causing deleterious photoelectrical impact to the fabricated imaging member. Examples of such high hole mobility

transporting compounds or molecules include the charge transport compounds represented by the molecular Formula (II) below:

FORMULA (II)



where R1, R2, R3, R4, R5 and R6 are each independently selected from hydrogen, halogen, and an alkyl, an aryl, or a cyclo-alkyl group which having 1 to 18 carbon atoms. The second (top) charge transport layer comprises a lesser amount of charge transport molecules than the first (bottom) charge transport layer. Preferably, the second (top) charge transport layer comprises between about 20 and about 45 weight percent, more preferably between about 30 and about 40 weight percent, of the high hole mobility transport compounds. The fabricated imaging member may also require an anti-curl layer to be coated onto the back side of the support substrate to render imaging member flatness.

Please substitute the following amended paragraph for the pending paragraph beginning on page 8, line 8:

Other aspects of the mechanical function improvements illustrated herein by the charge transport layer relate to an imaging member comprising:

a supporting flexible substrate having a conductive surface or layer,

an optional hole blocking layer,
an optional adhesive layer,
a charge generating layer, and,

a dual charge transport layer comprising at least a first (bottom) charge transport layer and a second (top) charge transport layer, both formed from solid solutions comprising a film forming polymer binder and a hole transporting diamine (preferably the binder used is of the same polymer for both layers), wherein the first (bottom) charge transport layer comprises from about 50 to about 90 weight percent, preferably from about 50 to about 70 weight percent, of an aromatic diamine hole transporting compound such as the compound of Formula (I) or any of the aromatic diamines named above, while the second (top) charge transport layer comprises a high hole charge transporting compound such as the diamine of Formula (II) in a lesser amount of between about 20 and about 45 weight percent, but preferably between about 30 and about 40 weight percent. An anti-curl layer may be coated to the back side of the support substrate to provide imaging member flatness.

Please substitute the following amended paragraph for the pending paragraph beginning on page 12, line 22:

For negatively charged photoreceptors, any suitable hole blocking layer 34 capable of forming an electronic barrier to prohibit the migration of holes between the adjacent photoconductive layer and the underlying conductive layer, for example, a titanium layer, may be utilized. A hole blocking layer may be needed to effect ground plane hole injection suppression and it is comprised of any suitable material. The charge (hole) blocking layer may include polymers, such as, polyvinylbutyral, epoxy resins, polyesters, polysiloxanes, polyamides, polyurethanes, HEMA, hydroxylpropyl allulose cellulose, polyphosphazine, and the like, or may be nitrogen containing siloxanes or silanes, nitrogen containing titanium or zirconium compounds, such as, titanate and zirconate. Hole blocking layers having a thickness in wide range of from about 50 Angstrom (0.005 micrometer) to about 10 micrometers depending on the type of material chosen for use in a photoreceptor design. Typical hole blocking layer materials are, for example, trimethoxysilyl propylene diamine, hydrolyzed trimethoxysilyl propyl ethylene diamine, N-beta-(aminoethyl) gamma-amino-propyl trimethoxy silane, isopropyl 4-aminobenzene sulfonyl, di(dodecylbenzene sulfonyl) titanate, isopropyl di(4-

aminobenzoyl)isostearoyl titanate, isopropyl tri(N-ethylamino-ethylamino)titanate, isopropyl trianthranil titanate, isopropyl tri(N,N-dimethyl-ethylamino)titanate, titanium-4-amino benzene sulfonate oxyacetate, titanium 4-aminobenzoate isostearate oxyacetate, $[\text{H}_2\text{N}(\text{CH}_2)_4]\text{CH}_3\text{Si}(\text{OCH}_3)_2$, gamma-aminobutyl) methyl diethoxsilane, and $[\text{H}_2\text{N}(\text{CH}_2)_3]\text{CH}_3\text{Si}(\text{OCH}_3)_2$, (gamma-aminopropyl)-methyl diethoxsilane, as disclosed in U.S. Patents 4,338,387, 4,286,033 and 4,291,110. Other suitable charge blocking layer polymer compositions are also described in U.S. Patent 5,244,762. These include vinyl hydroxyl ester and vinyl hydroxy amide polymers wherein the hydroxyl groups have been partially modified to benzoate and acetate esters which modified polymers are then blended with other unmodified vinyl hydroxyl ester and amide unmodified polymers. An example of such a blend is a 30 mole percent benzoate ester of poly (2-hydroxyethyl methacrylate) blended with the parent polymer poly (2-hydroxyethyl methacrylate). Still other suitable charge blocking layer polymer compositions are described in U.S. Patent 4,988,597. These include polymers containing an alkyl acrylamidoglycolate alkyl ether repeat unit. An example of such an alkyl acrylamidoglycolate alkyl ether containing polymer is the copolymer poly(methyl acrylamidoglycolate methyl ether-co-2-hydroxyethyl methacrylate). The disclosures of the U.S. Patents are incorporated herein by reference in their entirety.

Please substitute the following amended paragraph for the pending paragraph beginning on page 18, line 29:

Although the film forming polymer binder used may be of different materials in either charge transport layer, nonetheless it is preferably preferable to have identical polymer binder in both top and bottom charge transport layers for the benefit of providing excellent interfacial adhesion bonding between these two layers.

Please substitute the following amended paragraph for the pending paragraph beginning on page 19, line 1:

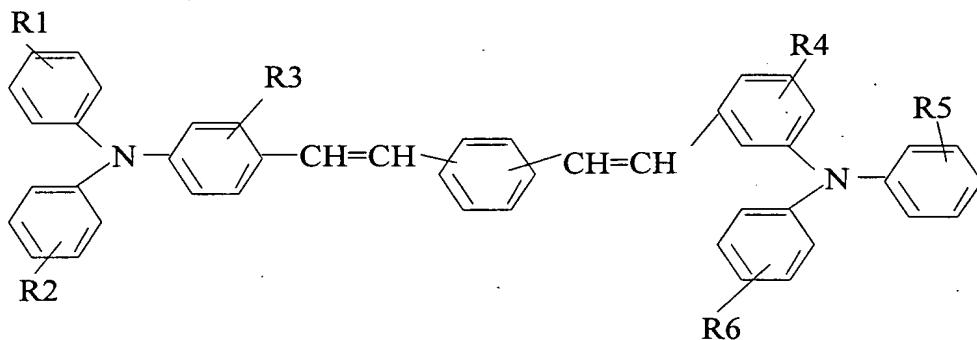
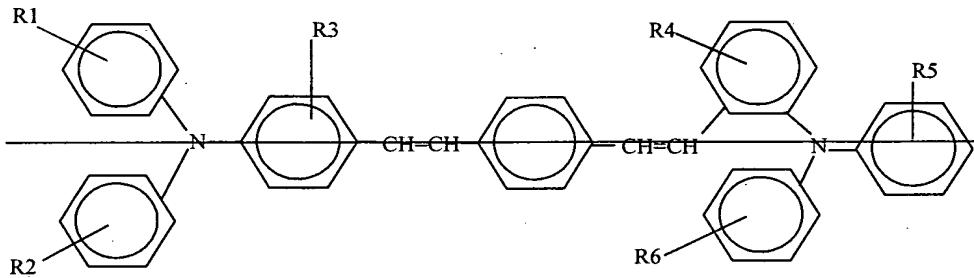
The polymer binder used for the charge transport layers may be, for example, selected from the group consisting of polycarbonates, poly(vinyl carbazole), and polystyrene. It is, however, preferred to use polycarbonate, especially of being a

poly(4,4'-isopropylidene diphenyl carbonate) or a poly(4,4'-diphenyl-1,1'-cyclohexane carbonate).

Please substitute the following amended paragraph for the pending paragraph beginning on page 19, line 18:

~~While the~~ The second (top) charge transport layer 40T comprises a lesser amount of [[,]] between about 20 and about 45 weight percent of [[a]] high mobility charge transport compounds such as the high mobility hole diamine set forth below in Formula (II). This results in effective suppression of charge transport layer cracking problem and thereby provides effectual extension of the photoreceptor belt mechanical functioning life in the field. The reason that the second or top charge transport layer needs a lesser amount of the novel diamine loading is due to the fact that the diamine has a 2-times hole mobility capacity 2-times greater than that of using the typical aromatic diamine counterpart, so it will require a much lesser quantity addition to effect the same imaging member photo-electrical functioning outcome. The molecular formula of the high hole transporting diamine is represented by:

FORMULA (II)



where R1, R2, R3, R4, R5, and R6 are each independently selected from hydrogen, halogen, and an alkyl, an aryl, or a cyclo-alkyl group having 1 to 18 carbon atoms.

Please substitute the following amended paragraph for the pending paragraph beginning on page 20, line 16:

For exemplary purposes only, a typical dual charge transport layer is a solid solution including an activating organic compound molecularly dispersed or dissolved in a preferred polycarbonate binder of being either a poly(4,4'-isopropylidene diphenyl carbonate) or a poly(4,4'-diphenyl-1,1'-cyclohexane carbonate). The prepared dual charge transport layer is generally having has a Young's Modulus of about 3.5×10^5 psi and also with a thermal contraction coefficient of about $7 \times 10^{-5}/^{\circ}\text{C}$. Each of the dual charge transport layer has a glass transition temperature Tg of between about 75°C and about 100°C.

Please substitute the following amended paragraph for the pending paragraph beginning on page 23, line 31:

The selection of a thermoplastic film forming thermoplastic polymer for the anti-curl layer application should satisfy the physical, mechanical, optical, and thermal requirements, as detailed herein. Suitable polymer materials for use in the anti-curl back coating include: polycarbonates, polystyrenes, polyesters, polyamides, polyurethanes, polyarylethers, polyarylsulfones, polyarylate, polybutadienes, polysulfones, polyethersulfones, polyethylenes, polypropylenes, polyimides, polymethylpentenes, polyphenylene sulfides, polyvinyl acetate, polysiloxanes, polyacrylates, polyvinyl acetals, polyamides, polyimides, amino resins, phenylene oxide resins, terephthalic acid resins, phenoxy resins, epoxy resins, phenolic resins, polystyrene and acrylonitrile copolymers, polyvinylchloride, vinylchloride and vinyl acetate copolymers, acrylate copolymers, alkyd resins, cellulosic film formers, poly(amideimide), styrene-butadiene copolymers, vinylidenechloridevinylchloride copolymers, vinylacetate-vinylidenechloride copolymers, styrene-alkyd resins, and the like. These polymers may be block, random or alternating copolymers. In addition, other polymers may also include polycarbonate resin, polyvinylcarbazole, polyester, polyarylate, polyacrylate, polyether, polysulfone, polystyrene, polyamide, and the like.

Molecular weights can vary from about 20,000 to about 150,000. Polycarbonates may be a bisphenol A polycarbonate material such as poly(4,4'-isopropylidene-diphenylene carbonate) having a molecular weight of from about 35,000 to about 40,000, available as Lexan LEXAN 145 from General Electric Company and poly(4,4'-isopropylidene-diphenylene carbonate) having a molecular weight of from about 40,000 to about 45,000, available as Lexan LEXAN 141 also from the General Electric Company. A bisphenol A polycarbonate resin having a molecular weight of from about 50,000 to about 120,000, is available as Makrolon MAKROLON from Farbenfabriken Bayer A.G. A lower molecular weight bisphenol A polycarbonate resin having a molecular weight of from about 20,000 to about 50,000 is available as Merlon MERLON from Mobay Chemical Company. Another type of polycarbonate of interest is poly(4,4-diphenyl-1,1'-cyclohexane carbonate), which is a film forming thermoplastic polymer structurally modified from bisphenol A polycarbonate; it is commercially available from Mitsubishi Chemicals. All of these polycarbonates have a Tg of between about 145°C and about 165°C and with a thermal contraction coefficient ranging from about $6.0 \times 10^{-5}/^{\circ}\text{C}$ to about $7.0 \times 10^{-5}/^{\circ}\text{C}$.

Please substitute the following amended paragraph for the pending paragraph beginning on page 25, line 6:

The anti-curl layer 33 formulation may also include the addition of a small quantity of a saturated copolyester adhesion promoter to enhance its adhesion bond strength to the substrate support 32. Typical copolyester adhesion promoters are Vitel VITEL polyesters from Goodyear Rubber and Tire Company, Mor-Ester MOR-ESTER from Morton Chemicals, Eastar EASTAR PETG from Eastman Chemicals, and the like. To impart optimum wear resistance as well as maintaining the coating layer optical clarity, the anti-curl layer may further be incorporated into its material matrix, with about 5 to about 30 weight percent filler dispersion of silica particles, Teflon particles, PVF₂ particles, stearate particles, aluminum oxide particles, titanium dioxide particles or a particle blend dispersion of Teflon and any of these inorganic particles. Suitable particles used for dispersion in the anti-curl back coating include particles having a size of between about 0.05 and about 0.22 micrometers, and more specifically between about 0.18 and about 0.20 micrometers.

Please substitute the following amended paragraph for the pending paragraph beginning on page 29, line 17:

An electrophotographic imaging member web was prepared by following the exact same procedures and using the same materials as those described in Comparative Example, but with the exception that the single 29-micrometer thick charge transport layer was replaced by a dual-layer consisting of a 15 micrometers bottom charge transport layer and a 14 micrometers top charge transport layer, with both layers having same weight ratio of 1:1 ~~N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4-4'-diamine~~ N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4,4'-diamine and MAKROLON 5705 (equivalent to 50 weight percent of hole transport compound and 50 weight percent polymer binder). It is worth noting that the applied bottom charge transport layer was dried prior to the subsequent application of the top charge transport layer.

Please substitute the following amended paragraph for the pending paragraph beginning on page 29, line 30:

Six charge transport layer solutions were prepared according to the procedures described in the Comparative Example, except that the solutions contain varying concentration of charge transport compound ~~N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4-4'-diamine~~ N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4,4'-diamine of formula (I). When each was coated over a releasing surface of a thick polyvinyl fluoride substrate and dried at 135 degrees Celsius to remove the methylene chloride layer, six dried charge transport layers, containing 50, 40, 30, 20, 10, and 0 weight percent charge transport compound respectively in the MAKROLON binder based on the total weight of each resulting charge transport layer, were obtained. The resulting six dried charge transport layers obtained were each 29 micrometers in thickness.

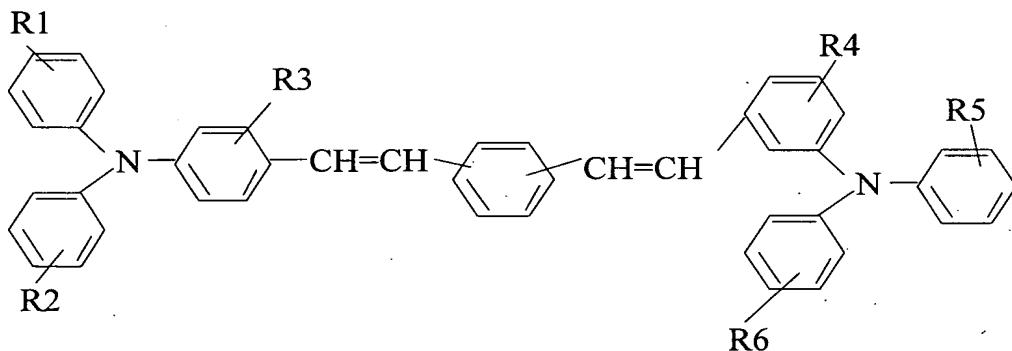
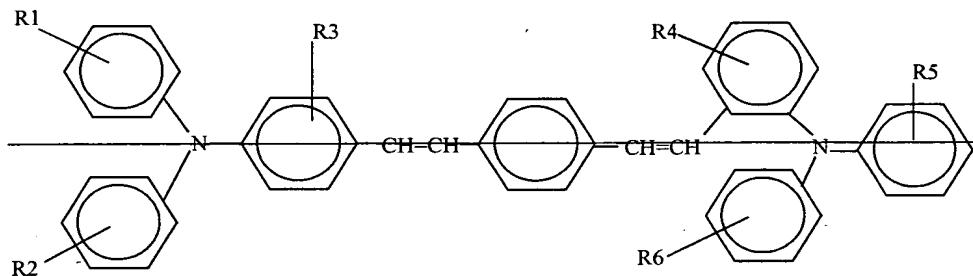
Please substitute the following amended paragraph for the pending paragraph beginning on page 30, line 21:

To demonstrate the mechanical impact on a charge transport layer in the imaging member, five electrophotographic imaging members were prepared according to the procedures and using the same material as that described in the Comparative Example, with the exception that the ~~N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4,4'-diamine~~ N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4,4'-diamine of formula (I) content in the charge transport layer was varied to give respective 50, 40, 30, 20, and 10 weight percent in the MAKROLON binder based on the total weight of each resulting charge transport layer. The imaging members were cut to give 1 inch x 6 inch samples and each subjected to low speed sample tensile elongation, using an Instron Mechanical Tester, to determine the exact extent of stretching at which onset of charge transport layer cracking became evident by sample examination under 100x magnification with a stereo optical microscope. The charge transport layer cracking strains were 3.25, 6.5, 10.5, 15.5, and about 64 percent for the corresponding imaging members having 50, 40, 30, 20, and 10 weight percent loaded charge transport layer. The mechanical property enhancement in the charge transport layer was again observed in the imaging members having reduced transport compound loading levels, supporting the mechanical property improvement seen in Example I.

Please substitute the following amended paragraph for the pending paragraph beginning on page 31, line 14:

Four electrophotographic imaging members were prepared according to the procedures and using the same material as described in Example II, with the exception that the N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4,4'-diamine N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4,4'-diamine of Formula (I) utilized in the charge transport layer was replaced by a high hole mobility terphenyl diamine (styrene stilbene) charge transport compound represented by:

FORMULA (II)



where R1, R2, R3, R4, R5, and R6 are each independently selected from hydrogen, halogen, and an alkyl, an aryl, or a cyclo-alkyl group which have 1 to 18 carbon atoms, to give concentrations of 50, 40, and 30 weight percent in the MAKROLON binder based on the total weight of each resulting charge transport layer. These imaging members were then analyzed along with corresponding imaging member counterparts (each charge transport layer having respective 50, 40, and 30 percent by weight in polycarbonate) selected from Example II for photo-electrical function, to show that the drift mobility of imaging members having a charge transport layer prepared with this compound is approximately one order of magnitude higher than

those of respective counterparts using ~~N,N'-diphenyl-N,N'-bis(3-methylphenyl)-[1,1'-biphenyl]-4,4'-diamine~~ N,N'-diphenyl-N,N'-bis(3-methylphenyl)-[1,1'-biphenyl]-4,4'-diamine of Formula (I).

Please substitute the following amended paragraph for the pending paragraph beginning on page 32, line 14:

An imaging member web stock was prepared by following the procedures and using the same materials as described in the Control Example, but with the exception that the top layer of the dual charge transport layer was replaced with a 14 micrometer thick top transporting layer comprising 35 weight percent ~~N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4,4'-diamine~~ N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4,4'-diamine and 65 weight percent MAKROLON polymer binder.